show the line at λ 500 first observed in a comet by Dr. Huggins in the year 1866. It remains for those who hold that the physical structure and temperature of comets and nebulæ are not similar in each case to explain the phenomena observed in a more simple and sufficient way.

June 19, 1890.

Mr. JOHN EVANS, D.C.L., LL.D., Treasurer, in the Chair.

The Rev. J. Kerr, Prof. W. H. Perkin, jun., Mr. D. Sharp, and Mr. W. F. R. Weldon were admitted into the Society.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "On the Determination of some Boiling and Freezing Points by means of the Platinum Thermometer." By E. H. GRIFFITHS, M.A., Sidney Sussex College, Cambridge. Communicated by R. T. GLAZEBROOK, F.R.S. Received May 27, 1890.

(Abstract.)

The paper contains an account of experiments made with a view of—

(I.) Comparing the closeness of agreement between the readings of platinum thermometers made from different samples of wire arranged in different manners and insulated by different materials.

(II.) Ascertaining some accurate method of graduating such thermometers without the direct use of the air thermometer.

(III.) The determination of certain boiling and freezing points.

Eight thermometers were constructed. The resistance of the platinum coils used varied from about 4 to 50 ohms. Full particulars of these thermometers are given in the paper.

The insulating substance in thermometers A, B, C, D was glass only; but the internal arrangements were different, as also were the samples of platinum wire used in their construction.

The form finally adopted (that of E, F, G) was as follows:—A coil of fine platinum wire was wound on a roll of asbestos paper and slipped into a thin hard-glass tube. Thick platinum wires ran from

this coil to the top of the instrument, and the unimmersed portion of the stem was surrounded by the outer tube of a condenser, and kept at a constant temperature by a flow of tap-water. The resistance of this stem was so small that the change in resistance caused by the changes in the temperature of the tap-water might be neglected.

The diameter of these thermometers was less than $\frac{3}{16}$ of an inch, and their length about 18 inches. They were extremely sensitive, and could therefore be used to trace the rise in temperature due to suffusion, the freezing points of the metals experimented upon being determined by the limit of this rise.

These thermometers were graduated by the temperature of the boiling points of water, naphthalene, benzophenone, and sulphur, and the freezing point of water.

The values obtained by Crafts ('Paris, Soc. Chim. Bull.,' vol. 39) were used in the case of naphthalene and benzophenone, and Regnault's value of the boiling point of sulphur.* The purity of the samples was ascertained by fractional distillation and by the temperature of the melting points. The selection of these temperatures was forced upon me by the results of my experiments, and the reasons for their adoption are fully given in the paper.

The results were plotted in the manner suggested by Callendar ('Phil. Trans.,' A, 1887), and on a scale such that a difference of 0·02° could be read with certainty.

The curves thus obtained differed considerably from each other and from the curve given by Callendar.† However, intermediate temperatures deduced from these curves showed remarkably close agreement.

In no case (the total number of experiments exceeds 300) is the divergence of any one experiment from the mean value obtained from all the thermometers as great as 0·2°, and if only the results obtained from thermometers E, F, and G be taken, the divergence is in no case as great as 0·05°.

The chief difficulties which presented themselves were—

(*a*.) Variations in the resistance of the connexions between the thermometer coil and the resistance coils.

(*b*.) Variations in the temperature of the resistance coils themselves.

(*c*.) The rise in temperature of the thermometer coil due to the current used when measuring its resistance.

* Boiling point of naphthalene (760 m.m.) = 218°·06.
,, benzophenone ,, = 306°·08.
,, sulphur ,, = 448°·34.

† A discussion of the probable cause of these divergences is given in an appendix to the paper.

Table II.

I. Nature of experiment.	II. Thermometer used.	III. Number of determinations.	IV. Mean temperature.	V. Extreme divergence of any experiment.	VI. Temperature adopted.*	Previous observers.
B. p. of aniline (760 mm.)— Sample I.	F.	6	184·23	+ ·03° − ·01	184·22	Ramsay, 184·41. Thorpe, 183·7.
	E.	3	184·19	+ ·02 − ·01		
Sample II.	E.	4	184·21	+ ·03 + ·02		
	G.	2	184·23	± ·00		
B. p. of methyl salicylate (760 mm.)	F.	1	223·21	—	223·19	Ramsay, 222·88. Cahours, 222.
	E.	3	223·18	+ ·03 − ·03		
B. p. of triphenyl methane (770·8 mm.)	E.	1	357·38	—	357·35	Kekulé, 355 (760). Crafts, 358 (754).
	G.	1	357·33	—		
B. p. of mercury (760 mm.)	F.	2	357·68	± ·00	357·65	Regnault, 357·25. Ramsay, 358·2.
	E.	4	357·64	+ ·02 − ·01		
	G.	2	357·62	± ·00		
Freezing point of tin	F.	3	232·00	+ ·02 − ·01	232·03	Reimsdyk, 228·5. Kupffer, 230. Person, 232·7. Crichton, 238.
	G.	4	232·02	± ·02		
	E.	2	232·08	± ·00		

Freezing point of bismuth— Sample I.	E. G.	3 3	269·68 269·69	+ ·02 − ·01 ± ·01	269·68	Person, 270·5. Reimsdyk, 268·3.
Sample II (Johnson and Matthey.)	E. G.	3 3	269·69 269·68	+ ·02 − ·04 + ·02 − ·01		
Freezing point of cadmium— Sample I. (Harrington Bros.)	E. G.	3 2	321·51 321·49	+ ·01 − ·00 + ·02 − ·01		Person, 320·7. Reimsdyk, 320. Van der Wyde, 325.
Sample II (Johnson and Matthey.)	E. G.	2 3	321·70 321·64	± ·02 ± ·02	321·67	
Freezing point of lead— Sample I. (Harrington Bros.)	F.	3	328·27	+ ·02 − ·01		Person, 326·2. Kupffer, 334. Quincke, 330.
Sample II (Johnson and Matthey.)	G. E.	3 3	328·79 328·77	+ ·00 − ·01 ± 02	328·78	
Freezing point of zinc	G. E.	3 3	421·21 421·25	± ·01 + ·01 − ·02	421·23	Reimsdyk, 420. Wright and Luff, 420. Person, 433·3. (Other observers range from 342 (Daniell) to 450 (Boussingault).

In no case would the divergence shown in Column V affect the fourth figure in Column VI.

* The temperatures in Column VI are expressed in terms of the air thermometer.

(*d.*) The presence of currents due to thermal effects.

(*e.*) Superheating during distillation, and radiation from the source of heat to the thermometer.

(*f.*) The changes in boiling points due to changes in the barometer.

(*g.*) Oxidation of the metals when fluid.

For an account of the manner in which these difficulties were overcome, and of the further precautions taken to secure accuracy, reference must be made to the paper.

The boiling points of the following substances were determined:— Aniline, methyl salicylate, triphenylmethane, and mercury; and the freezing points of tin, bismuth, cadmium, lead, and zinc.§ Every endeavour was made to secure pure specimens of these bodies.

Full particulars of the individual experiments are given in the tables attached to the paper, and the results are summarised in the accompanying tables.

In Table I, I give certain boiling points as determined by means of thermometers A, B, C, D, and E*. I have thought it unnecessary to give details in Table I, since the forms of thermometers used therein were ultimately discarded in favour of the form adopted in E, F, and G. The mean results, however, are in close agreement with those given in Table II (see pp. 222—223).

Table I.

Thermometers used.	A.	B.	C.	D.	E*.	Mean.
B. p. of aniline (760 mm.)	184·32	184·27	184·29	184·21	184·24	184·27
„ methyl salicylate „	223·08	223·12	223·16	..	..	223·12
„ mercury „	357·61	357·59	357·65	357·54	..	357·60

In Table II, I give the results obtained from thermometers E, F, and G, together with the extreme departure of any single determination from the mean.

In case the values of the fixed points assumed when graduating these thermometers are hereafter found to be inaccurate, sufficient data are given in the tables attached to the paper for the correction of the temperatures given in column VI.

The results given bear out the following conclusions:—

I. That although the curves of platinum temperature obtained

§ The apparatus used for melting these metals, and for stirring them when cooling, was kindly placed at my disposal by Messrs. Neville and Heycock, and is described by them in their paper on the Melting Point of Alloys ('Journal of the Chemical Society,' May, 1890).

from different thermometers vary considerably, intermediate temperatures deduced from these curves are in practical agreement.

II. That thermometers made and graduated as described may be used for the accurate determination of temperatures up to about 500° C.

II. "On the alleged Slipping at the Boundary of a Liquid in Motion." By W. C. DAMPIER WHETHAM, B.A., Coutts Trotter Student of Trinity College, Cambridge. Communicated by J. J. THOMSON, M.A., F.R.S., Cavendish Professor of Experimental Physics, Cambridge. Received June 7, 1890.

(Abstract.)

The experiments of Helmholtz and Piotrowski* on the oscillations of a metal sphere suspended bifilarly, and filled with various liquids, gave finite values to the slipping coefficients. The inside of the sphere was gilded and polished, and the value obtained for the coefficient λ was, in the case of distilled water, 2·3534 mm. From some experiments of Girard† on transpiration through copper tubes, Helmholtz deduces the value $\lambda = 0·3984$ mm. for water flowing past a copper surface.

In treatises on hydrodynamics, it is shown that when the motion through a tube is linear, the flux is

$$\frac{1}{8}\frac{\pi r^4}{\rho\mu}\frac{p_1-p_2}{l}+\frac{1}{2}\frac{\pi r^3}{\beta}\frac{p_1-p_2}{l},$$

or

$$\frac{1}{8}\frac{\pi(p_1-p_2)}{\mu\rho l}\left\{r^4+4\mu\rho\frac{1}{\beta}r^3\right\}.$$

In Helmholtz's notation this becomes (ρ being taken as unity)

$$\frac{1}{8}\frac{\pi(p_1-p_2)}{\mu l}\{r^4+4\lambda r^3\}.$$

Putting $r = 0·05$ and $\lambda = 0·23534$, we get

$$\frac{1}{8}\frac{\pi(p_1-p_2)}{\mu l}\times 117·67\times 10^{-6};$$

whereas if there is no slip, so that λ vanishes, the flux becomes

$$\frac{1}{8}\frac{\pi(p_1-p_2)}{\mu l}\times 6·25\times 10^{-6}.$$

* 'Sitzungsberichte der Wiener Akademie,' vol. 40.

† 'Mémoires de l'Institut,' 1813—1815.